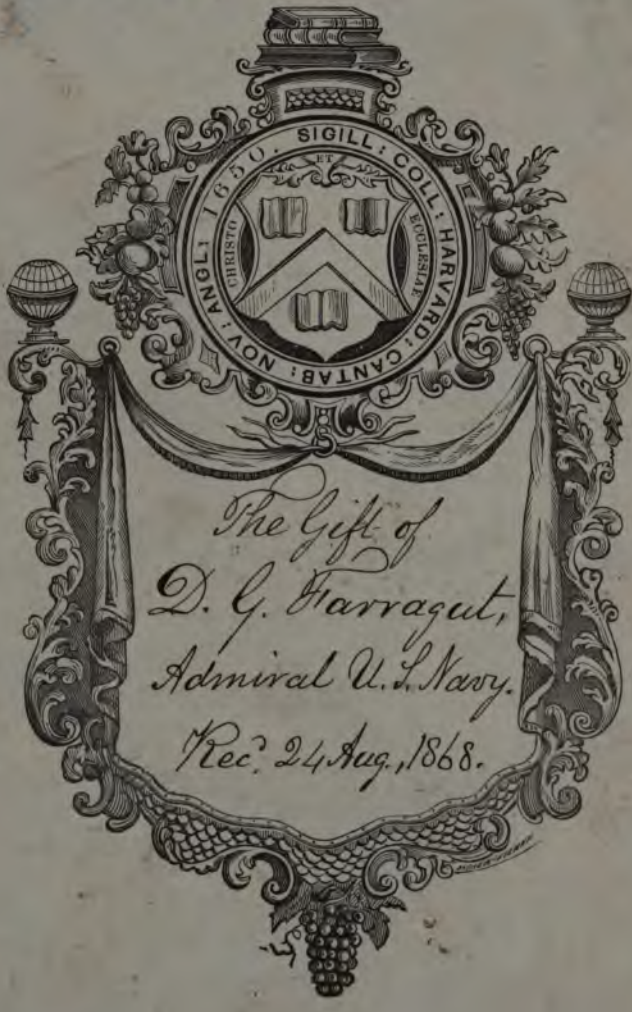

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D. G. Farragut
Admiral
U. S. Navy
June 26th 1867

EXPERIMENTS

TO ASCERTAIN THE

STRENGTH AND ENDURANCE

OF

NAVY GUNS.

WASHINGTON:
PRINTED BY A. O. P. NICHOLSON.
1854.

ORDER AND INSTRUCTIONS.

(A.)

BUREAU OF ORDNANCE AND HYDROGRAPHY,
September 3, 1852.

SIR: You will attend at Fort Monroe and superintend the experiments to be made at that place for the purpose of testing the endurance of different classes of navy guns.

Enclosed are instructions as to the manner in which these tests are to be made.

You will please use all diligence in these experiments, and have them conducted with the least possible expense consistent with the object of them.

If not more than twenty-five barrels of powder can be conveniently mixed at one time, that quantity may be used, and the strength of the mass tested.

Respectfully, your obedient servant,

C. MORRIS,
Chief of the Bureau.

Commander D. G. FARRAGUT,
Asst. Inspector of Ordnance, U. S. N., Norfolk, Va.

(B.)

BUREAU OF ORDNANCE AND HYDROGRAPHY,
September 3, 1852.

SIR: In making the tests for the endurance and strength of the guns which have been or may be directed to be sent to Fort Monroe, the following instructions are to be observed:

The guns are to be loaded with their respective distant-firing charges of proof powder when a single shot or shell is to be fired, and with the charges for near firing, or for double shotting, when two shot or shells shall be used, as shown in the table annexed.

Shell-guns are to be fired with single shells, except as hereinafter directed.

Shot-guns are to be fired, as a set, forty times single shotted, and ten times with two shot and one grommet wad, alternately, until they shall have been fired five hundred times, or shall have burst, or otherwise become unserviceable, when they are to be dismounted and reported.

At the close of every set of firings with single, and also with double shot, the guns and vents are to be carefully examined, the bores measured with the star-gauge at every inch behind the trunnions, and every four inches forward of them, and the results, with any other important facts connected with the guns, carefully noted in a journal, in which are also to be noted all other facts connected with the proof of each gun or its carriage and equipments, such as the effect on the carriage, guns, beds, &c., &c.

After firing each set of forty single and ten double, or fifty single shot or shells, the guns must be left until they become cool.

In loading and firing, the course is to be as nearly as possible that which would be usual in action, including rapidity for each set of firings, the object being to ascertain the endurance of the guns, as used for ordinary service in distant and close action.

As has been before stated, the powder must be proof, and of as nearly uniform strength and character as practicable, and the shot and shells of the same general weight and size, that a fair comparison may be made between the endurance of different guns.

If, upon examination, the officers in charge should find that relative or positive ranges, or other desirable information, can be combined with the tests for endurance, they will report the same for the consideration of the Bureau.

Should the shell-guns stand four hundred and seventy-five fires with single shells, twenty-five discharges may be made with two shells fuzed, and with blowing charges, to ascertain whether or

not the shells will be broken, or if the certainty of their proper explosion will be injured when two are used together.

It is supposed that many of the shot and shells can be recovered, and this is to be done, as far as possible, to save expense.

Guns which may stand the required five hundred discharges, are then to be dismounted and placed on the ground in a situation to be conveniently fired with increased charges, as follows:

The distant-firing charge of powder is to be increased one-third, and for shot-guns three shot are to be used in the first five fires; the next five, four shot; and thus increasing one shot for every five fires, till the gun is filled within a calibre of its face, or till it bursts. Should it stand more than this, then the charge of powder is to be increased to the proof charge, and as many shot used as the gun will contain, till it bursts.

The enlargement of the vent is to be carefully noted at every hundred fires. If it should become enlarged so as to admit a priming-wire of four-tenths of an inch diameter, the firing is to be suspended, and report made immediately, that the vent may be bushed, if deemed advisable.

For shell-guns, the charge of powder is to be increased in the same manner and proportions as directed for shot-guns; but solid shot instead of shells are to be used, beginning with one for the first five fires, and adding one as directed for shot-guns.

When a gun bursts, some of the larger fragments of each are to be preserved for further orders, and its number, as previously entered on the journal, immediately stamped on them, that specimens for density may be taken, the crystallization of the metal be observed and noted, and the whole compared with the endurance of the gun.

Respectfully, your obedient servant,

C. MORRIS,
Chief of the Bureau.

Commander D. G. FARRAGUT,
Asst. Inspector of Ordnance, U. S. N., Norfolk, Va.

TABLE OF SERVICE AND PROOF CHARGES.

SHOT-GUNS.

ORDNANCE.		SERVICE CHARGES.			PROOF CHARGES.		
Calibre.	Weight.	For distant firing.	For ordinary firing.	For two projectiles.	Powder.	Solid shot	Service junk wads.
64 pdr.	106 cwt.	16 lbs.	12 lbs.	8 lbs.	20 lbs.	2	1
32 "	61 "	10 "	8 "	6 "	16 "	2	1
32 "	57 "	9 "	8 "	6 "	15 "	2	1
32 "	51 "	8 "	7 "	5 "	13 "	2	1
32 "	46 "	7 "	7 "	5 "	12 "	2	1
32 "	42 "	6 "	6 "	4 "	10 "	2	1
32 "	33 "	4½ "	4½ "	4 "	10 "	1	1
32 "	27 "	4 "	4 "	3 "	9 "	1	1

SHELL-GUNS.

ORDNANCE.		SERVICE CHARGES.			PROOF CHARGES.		
Calibre.	Weight.	For distant firing.	For ordinary firing.	For near firing.	Powder.	Solid shot.	Service junk wads.
10-inch.	89 cwt.	10 lbs.	9 lbs.	8 lbs.	18 lbs.	1	1
8 "	63 "	9 "	7 "	6 "	16 "	1	1
8 "	55 "	7 "	7 "	6 "	14 "	1	1

SUBSTANCE

OF THE

REPORT MADE BY COMMANDER D. G. FARRAGUT.

FORT MONROE, OLD POINT COMFORT,
August 31, 1853.

SIR: In obedience to your order and instructions of September 3, 1852, (marked A and B,) herewith appended, I proceeded to Old Point, and erected a battery on the beach, at a suitable place designated by the commanding officer, General Bankhead, and conducted the firing of the different guns in the manner and under all the various circumstances designated by the Bureau.

I was further directed to test, as far as possible, all the gun-carriages, implements, &c., belonging to the guns of the navy; and, in fact, to give my close attention to all practical facts interesting to the Ordnance department.

In the performance of this duty, I have followed the instructions of the Bureau, by firing the different shot-guns Nos. 20, 21, 51, 574, 657, 671, 688, 695, 707, 710 and 11, with their highest service charges of powder and one shot, forty rounds each, and with the reduced charges of powder and two shot, ten rounds each, alternately, until they had each completed four hundred rounds of single shotting and one hundred rounds of double shotting. They were then dismounted, laid on the beach, and fired, in the manner prescribed in the instructions, viz: by increasing the service charge of powder one-third and beginning with three shot, and adding one shot every five rounds until the bore was nearly full. The charge was then increased to the proof charge, and so continued until the gun burst.

The shell-guns—No. 372, an 8-inch, of 63 cwt.; No. 160, an 8-inch, of 55 cwt.; No. 167, an 8-inch, of 55 cwt., and No. 11, a 10-inch—were fired, as directed, 475 rounds with the highest service charge of powder and one shell, and 25 rounds with the reduced charge of powder and two shells. They were then dismounted, laid on the beach, and fired with the increase of one-third to the highest service charge of powder, beginning with one solid shot, and adding one shot every five fires until the bore was nearly full. The charge was then increased to the proof charge, and so continued until the gun burst or was deemed by the Bureau as sufficiently tested, which was the case with No. 167, 8-inch, of 55 cwt., and No. 11, a 10-inch, of 88 cwt. The first (No. 167, 8-inch) stood 155 rounds with these charges, and the other (No. 11, 10-inch) stood 103 rounds; at which time neither showed any evidence of injury, other than a slight increase of the bores over the seat of the shot and the wear of the vents, which is more fully shown by the tables hereunto appended.

No. 34, an 8-inch, of 55 cwt. 3 qrs. and 16 lbs., was sent down from Washington. It had been fired by Lieutenant Dahlgren 200 times with one shell, and was then put on the lathe and 200 pounds turned off from the chase. It was afterwards remounted, and fired by him 188 times more with one shell, 17 times with two shells, and 9 times with one solid shot. I was directed to fire it 125 times, as follows: 100 times with seven pounds of powder and one shell, and 25 times with six pounds of powder and two shells. At the 13th round of double shell firing, with a charge of only four pounds of powder and two loaded shells, one of the shells exploded in the gun, and split the chase from the muzzle towards the rear two feet, on the right side, directly through a cavity out of which a plug for trying its tensile strength had been taken. I continued to fire with two shells and six pounds of powder the remaining 12 rounds, when the crack was only extended three-quarters of an inch. This induced the conclusion in my own mind that the explosion of the shell must have cracked the gun. I dismounted the gun and drilled a hole through the chase at the terminus of the crack, in hopes it would prevent its extension, and removed the gun to the bursting ground, where

it was fired with ten pounds of powder and one, two, and three shot, until it burst. For details, I refer to the tables hereunto appended.

I had frequently known 32-pounder shells to burst near the muzzles of 32-pounder guns, without the slightest injurious effect, but never had seen such explosions in the 8-inch guns of 55 cwt., which are much thinner in the chase.

As doubts had been expressed whether No. 34 had been burst by the wedging of the shot or by the force of the charge, a filled shell was placed in the muzzle of 8-inch gun No. 160, about 16 or 18 inches from the muzzle, and was exploded there. The explosion cracked the gun directly through the muzzle, above and below, running back a little beyond the rear of the chase-ring, and then running around in the rear of it. When the gun was afterwards fired with the bursting charges, it finally burst in a line with the cracks caused by the bursting of the shell, nearly horizontal from the muzzle, regularly to the breech; which I think clearly shows that the endurance of this gun, as well as No. 34, was injured by the shell explosions.

We subsequently tried a loaded shell in the chase of the 8-inch of 63 cwt., (No. 372,) which had proved to be of good material, and it blew the chase into many pieces.

The effects produced by the bursting of shells in the guns in our practice prove to my own satisfaction, that if a loaded shell should explode in the thinnest part of the chase of the 8-inch guns, it may crack or burst them, but not to the injury of the crew on board, for in no instance did the pieces fly more than two or three feet, and in two out of three such cases the explosion only cracked the gun; and that it would not injure our 32-pounder guns of 42 cwt. and upwards.

It is said a shell will not burst a gun in its flight out of the bore. I reply, that the 8-inch gun No. 34 was cracked when firing two loaded shells with a charge of only four pounds of powder, and after being so cracked it stood 12 fires with six pounds of powder and two unloaded shells, and only increased the length of the crack three quarters of an inch.

Gun No. 2, 9-inch, had been previously fired by Lieutenant Dahlgren, at Washington, 218 times, with various charges, from four and a half pounds up to twenty pounds of powder, and with one shot or shell. It was forwarded to me, with directions from the Bureau to fire it 280 times, viz: 250 times with ten pounds of powder and one shell, 10 times with two shells, and 20 times with one solid shot. I was afterwards further directed to fire it 500 times more with ten pounds of powder and one solid shot; which being completed, I was directed to continue its test by firing 500 rounds with two solid shot. At the 9th fire of this last series it burst.

At the 300th fire of the second series of fires, (or 320th with a solid shot,) a crack was discovered around the bottom of the chamber, and another longitudinally near the vent, extending one or two inches in front and rear of it. The gun split through this when it burst. The crack around the bottom of the chamber was plainly visible after it burst. It is wonderful that the gun should have endured so much after the cracks were discovered.

It will be perceived how difficult it is to make a comparison of this gun's endurance with the others, as its tests have been so different. There cannot, however, be a doubt that it was a good gun, but not fully corresponding with its tensile strength and density. I am inclined to the opinion that it was not equal to either No. 167, 8-inch; No. 11, 10-inch; or No. 372, 8-inch.

By reference to the tables it will be seen that there are two marked exceptions to the general rule of a good tensile strength and density giving a good endurance. These are guns No. 11, a 64-pounder of 106 cwt., and No. 597, a 32-pounder of 57 cwt.

For 597 I have no reasonable explanation to offer, except that there will no doubt occasionally occur exceptions to the rule from want of homogeneity in the metal.

As to the 64-pounder, No. 11, I can only say that thus far our experience, in the extreme tests of guns, goes to show that the heavy guns are not equal in strength to the lighter ones. Occasionally they stand a high test, but generally their endurance is not so great.

It is true 64-pounder, No. 11, stood 500 rounds with the heaviest

service charge, but in that particular all the guns were equal; it burst, however, at the second fire, with 20 pounds of powder and three shot, which was less than one-third increase on the service charge of powder which had been applied to all other guns.

Notwithstanding these occasional exceptions, we have agreed, generally, that the experiments warrant the opinion that the tensile strength and density of the iron may be received, as a general rule, for judging of the probable endurance of the guns.

It is deeply to be regretted that in the trials of the 32-pounders, Nos. 20, 51, 574, 671, and 688, the shot should have wedged by breaking, and thus prevented a fair test of their strength, as there is no doubt they would have shown great endurance, particularly Nos. 20 and 671, where the indentations from the wedges were very large. No. 20 was so scarified that it was wonderful how a gun could stand even one such wedging; yet it bore several, and at least fifty rounds were fired after the first wedging before it finally burst.

The 8, 9, and 10-inch shell-guns did not suffer from the same cause. In every case the bores of these guns were as smooth and free from injury of any kind as the day they were placed in battery, excepting always the wear of the gas over the seat of the shot. In the 9-inch, No. 2, this wear was found, on examination, to be from 0.12 to 0.25 of an inch deep.

A table, showing the enlargement of the vents, is appended, by which I think it will be seen that generally the best guns wore much the slowest in the vents.

I found it impossible to take impressions of the entire interior of the vents after the guns had burst, in consequence of the cavities being larger within than at the surface, but I am satisfied they wore by one rule only—where the iron was softest it yielded most to the blast, and its chemical action. The outer orifice, for several inches down, was generally worn in straight gullies, showing that it was caused by the force with which the blast passed out. Nearer to the charge, the heat being greater and less able to escape, the iron showed evident marks of fusion, and cavities were frequently seen, half an inch deep, running down toward the bore

rather than up to the surface, and larger at the bottom than at the top.

I am of the opinion that the vents enlarge very little after they are bushed, and therefore I think it avisable to bush a gun as soon as it has worn to three-tenths diameter. In no instance did the steel bush of one and a half inch deep blow out, but all the tubed bushes, put in by running zinc around them, gave us much trouble, and blew out in a very few fires. We therefore recommend steel bushes, when required, to be screwed in not more than two inches, nor less than one and a half inch deep.

DOUBLE SHOTTING.

When two shot were fired without a wad between the shot, about one-half were found whole in the butt; but with a junk wad between the shot, it was seldom that any were not broken.

SHELL FIRING.

Single 32-pounder shells appeared to stand 9 pounds of powder without breaking from the shock of the charge, and to explode at the proper time.

In our double-shelling we fired two empty shells with 6 pounds of powder, and generally neither broke; but when loaded shells of the same parcel were fired, even with only 4 pounds of powder, one or both burst in the gun. (See table annexed.)

I fired rounds in succession, first with two loaded and then with two unloaded shells. In only one case did the unloaded shells break, and in almost every instance one of the loaded shells broke in the gun.

The only way in which I could account for this effect was, that on examining the shells fired into the butt in double-shell firing, it was found that a plug was forced into the outer shell, and this most probably caused the explosion of the charge in the shell.

The impact of two shot and two shells, when fired together, acts very differently upon the shot and the shell. In both cases

a plug is formed by the impact; but in the shot the point of the plug is forced into the centre of the shot and splits it open, as in figure 1; while in the shell, the inner shell appears to force a plug into the other, with its base inward, as in figure 2.

Fig. 1.

Fig. 2.

It was deemed equivalent to a loss of both to fire two loaded shells, except with charges not exceeding four pounds of powder, though two unloaded shells might be safely fired with 6-pound charges if desired.

A wad that had been fired between two shot was found to be concave on both sides, with a hole in the centre the size of the surface of impact, and the wad was compressed to the hardness of wood.

PRIMING WIRES.

Experience satisfies me that a priming-wire need never be used at a gun except to clear the vent, and then the boring-bitt would answer as well.

In 12,000 fires, neither was found necessary for any other purpose. In one or two instances, when the primers failed, we ran the wire down the vent to ascertain if there was any impediment. I am convinced, also, that most of the accidents which occur from premature explosions in firing salutes or otherwise, are caused by the use of the priming-wire. When the gun is sponged, small burning fragments are sometimes forced into the vent, and left there until the cartridge is rammed home, when the captain of the gun, with his priming-wire, forces the burning fragment down upon the charge.

GUN CARRIAGES.

The guns were all tried on the carriages marked A, B, C, D, E, except the pivot-guns, which were tried on the Alleghany's old carriage and slide, wood and wood.

Carriage A was new, never used, much shrunken, last pattern, no braces to the axletrees, and was made for 32-pounder of 60 cwt.

Carriage B same as A in every particular, except that the ends of the axletrees were more shrunken, and had to be wedged up to tighten the bands; was also intended for 32-pounder of 60 cwt.

Carriage C was one of the Delaware's old 42-pounder carriages, cut out a little in the inside of the brackets, at the trunnion-holes, for the reception of the 8-inch guns of 63 cwt.—no doubt made when the ship was built; had braces to the axletrees; elm trucks, much split; otherwise the carriage was in good order; very little shrunken.

Carriage D was the Pook carriage of the Princeton, for an 8-inch of 55 cwt. gun.

Carriage E was the 9-inch gun carriage made for that gun at Washington.

The cam-elevator carriage was also a new 32-pounder carriage, made some years ago, but not used until at the testing battery. It was on old trucks; don't know when made—probably fifteen or twenty years ago.

For the 32-pounder of 47 cwt. and 51 cwt., we used the carriage for the 57 cwt. or 60 cwt. 32-pounder. The 8-inch guns of 63 cwt. and 55 cwt. were fired on the 42-pounder carriage (C) and on the 8-inch Pook's carriage (D) of the Princeton.

We at first thought the iron brace from the under part of the bracket, of the common truck carriage, to the under part of the front axletree, was indispensably necessary; but the carriage A, which was much shrunken by time and tested under the most unfavorable circumstances, stood 1,347 fires, although the fore axletree canted half an inch during the first 100 fires. The chin-bolts of this carriage broke, at the 1,347th fire, in the axletree. They were soon welded and the carriage put together again, and stood altogether 3,000 rounds.

Carriage B, although of the same kind as carriage A, was well screwed up and wedged; and it did not complain at 2,004 fires. Neither of these carriages had the above-mentioned braces to the

axletrees, and, except the dumb-trucks and breast-pieces, which were too slightly bolted, and flew off, they were as fit for service at the end of the firing as at the beginning.

Pook's carriage stood 1,039 fires without injury; but the pins which secured the compressor bars were too small, and broke twice. The old decayed pivot-carriage stood well under 500 fires from 10-inch and 500 from 64-pounder gun.

BEDS AND QUOINS.

Ward's Quoin.—Although this quoin possesses great advantages in special firing at moderate elevations, and at such elevations and depressions possesses great endurance, as shown by our experiments at this testing battery, still, at greater elevations, it will not keep its place, but flies out, and has a tendency to destroy the confidence of the captain of the gun. Its other disadvantages are, its expensiveness and liability of the female screw to injury when the breech of the gun is let down upon it for high elevations. On board the "Savannah," in firing twice with one loaded shell, (elevation 7°,) this quoin flew out both times.

ORDINARY BEDS AND QUOINS.

They have in no instance been found to stand well under the different circumstances of firing. With the first impulse of the gun to recoil, the bed and quoin fly forward. When the breeching stops the recoil, the breech rises and one or both fly out. It is by this double action that the knobs on the quoins are so frequently broken off. We found none of the ordinary quoins to stand unless lashed in their places.

The bed, if one is used, should be made with a double clamp, to go over the bed-bolt and key, thus:

In our practice the dowel-pins in the stool of the beds were bent by the forward action of the stool. When testing gun No. 710,

the quoin flew out at the 22d, 29th, 96th, and 151st fires; and with gun No. 597, on the 20th and 278th fire. With gun No. 707, fired with a breeching, the bed and quoin either flew out or worked forward every fire, unless they were lashed in their places, and even broke the lashing and flew out at the 197th fire; at the 246th fire the bed worked in and quoin flew out; at the 299th fire the dowel-pin had cut the axletree several inches towards the forward part, and neither bed nor quoin stood well until I had a plate put on the axletree to take the dowel pin. From the 350th fire, whenever the bed stood, the quoin invariably flew out, unless lashed in place.

Pook's elevating screw and bed would, I think, take the place of all other elevating apparatus, if it could be fitted to give required elevation and depression, as it is superior to Ward's, or any other we have tried, for stability.

The arrangement is simple, compact, and strong; is worked easily; is easily kept in order, and cannot fly out. It has been tested under the most unfavorable circumstances, as it was always fired at a depression, and although only calculated for a 32-pounder of 57 cwt., it stood ten fires under the 9-inch gun of 80 cwt., before it was broken by the great weight and recoil of the gun. Another recommendation is, that all the old carronade screws might be used in their arrangement.

It stood very well until it was placed under the 9-inch gun No. 2, for which it was too slight. The 265th fire, under 8-inch gun, broke off the handles; the 275th fire broke hinge and screw when firing one solid shot. I then fitted a screw through the axletree and placed the bed on it, with an iron socket to receive the end of the screw, which stood until the 396th fire, when the screw broke through the bed, the latter being indifferently made: had a new bed made, which stood until the gun burst; and that did not destroy its usefulness, as it only broke off one or two handles and a piece of the bed.

CAM ELEVATOR

Is a fixed screw, working in a ratchet-wheel about twelve inches in diameter, on the inside of the left bracket. The ratchet-wheel

is on the shaft which turns the cam that is placed under the breech of the gun, and by which its elevation is regulated. Its endurance appears to be undoubted, but it is not so simple or so good as the Pook screw, much more expensive, and more difficult to repair. The shaft of the crank is not sufficiently long to allow the crank handle to clear the breeching.

TRUCKS.

Lignumvitæ appears to be superior for trucks to anything we have ever seen. It deposites a kind of gum on the axletrees, which protects them from wear, and in 3,000 rounds the axletrees of carriage A were worn only 0.11 of an inch, and the trucks about 0.34, and were not impaired even then in the slightest degree for action, although they had been exposed on the beach twelve months previously.

Elm, or oak trucks, being made of different pieces, (the grain of the wood crossing at right-angles,) are much more severe upon the axletree; and where the wood is not well seasoned, the shrinkage renders the surface unequal, and of course more injurious both to the deck and the axletree. In our experiments they required one-third more men to work the gun than with lignumvitæ trucks.

CHOCKING QUOINS.

By placing these quoins at proper distances in the rear of the gun, they always caught it and terminated its recoil when fired without breechings. They will no doubt be found an excellent thing in action, on board a ship, to check recoil, or when there is much rolling motion, for they prevent the gun from running out as well as check the recoil. For 3,000 fires we used no breechings, and yet found no difficulty in controlling the recoil by these quoins.

BREECHINGS.

Rope of eight inches is considered sufficiently large for guns not over 9 inches calibre. We have tried them with and without

the side shackles on the carriage. In the latter case we used a piece of light stuff as a span over the chase of the gun, to keep the breeching out of the way of the trucks, and in 1,500 fires it appeared to answer very well; but I am not satisfied that it will answer so well on ship-board, where the space is much cramped, until it shall have been tested there.

BLOCKS.

The copper pins, hardened and used with lignumvitæ sheaves without bushes, appear to answer admirably for gun-tackle blocks. We used but one tackle instead of two, to run out our guns, and one set of blocks stood 1,147 fires before it wore away sufficiently to impair the block in the least; the sheave then rested on the shell of the block by the wear of the pin-hole.

TACKLE FALLS.

Three-inch rope appears to be sufficiently large for the heaviest guns, and Manilla rope possesses sufficient endurance for all service. We used it under the most disadvantageous circumstances, working in the sand and exposed to all kinds of weather, and the fall did not part until the 1,500th fire. The Manilla makes a difference in working the gun of two men less in fourteen.

HOOKS.

Many of the hooks to our gun-tackles were too small, several straightened out, and one or two broke during our test. They should not be less than one and a quarter inch in the bend of the nook, and up to one and a half inch for heavy guns.

LOCKS.

Lieut. Dahlgren's perforated lock, if fitted with exactness over the vent, the steel point sound, and the pins strong enough to stand

the shock of the recoil, and thus prevent the edge of the hammer from being thrown over the vent, will stand 200 or 300 fires, provided that the vent does not wear away faster than the orifice in the lock. Of six we tried, two stood 300 fires; one 190 fires; one 120 fires; one 127 fires; and one only 18 fires. Only the first two wore out fairly, where the vents of the guns wore slowly, and the steel points were burnt out to an edge. The lock-string was frequently burnt off, and the moment the blast struck the edge of the face of the hammer it threw it back with such force as to cut off the lock-string at almost every fire. We substituted chain-wire first, and afterwards quarter-inch iron, to prevent it. As stated above, the lock is good when everything is in order, but it is not always certain and reliable.

HIDDEN'S LOCK.

Hidden's lock appears to be almost without fault, and its endurance sufficient for all practical purposes. It stood 1,000 and 1,500 fires, and was only injured by the yielding of the pins which attach it to the lock-piece. When the vent wore too large for the hammer to cover it, or the face of the hammer worked forward of it, then the blast out of the vent wore away the head of the hammer, but it required a long time to disable the lock. Much difficulty might be prevented, if, when putting on the lock, the hammer was fitted over the vent so that the edge towards the muzzle barely covered that edge of the vent, leaving room for the hammer to work forward; or by making the pins stouter, to prevent their yielding, as has been done lately with success.

LOCK LANIARD.

Nothing could be better than either of the specimens we have been using, which were rope-laid and whipcord; both have stood for 5,000 fires, except where they have been burnt off, which was as often as once in a thousand rounds. A chain next to the lock would prevent this.

PRIMERS.

Our primers are not to be excelled. They only require a hard, steady pull of the lock-string. They never failed to penetrate the cylinder without pricking, as was proved by the fact that the priming-wires were never used for pricking the cartridge in all our firing; but when the vents of the guns become enlarged, the primers should be wrapped, as the jar of one gun might otherwise throw out the primers of the next gun. In firing 10,000 times, only 48 primers failed from all causes.

SPONGES.

The woven woolen sponges are very good for 400 or 500 fires, but soon after become unfit for service. The bristle sponge is, in my opinion, incomparably the best sponge for service. We used bristle sponges for many fires, during which time we have had no accident, and I am satisfied that the guns have been better cleaned than with the woolen sponges. The wear of one was not perceptible in 3,080 fires. They are easily kept clean, and are not liable to rot. The great advantage of the bristle sponge is, that one man can sponge a gun more easily with it than two can with a woolen sponge, unless the latter is well worn down.

RAMMERS.

They are as good as can be made. In chambered guns, they should be made to fit the chamber, and not the bore, that they may not jam in the chamber.

CYLINDERS.

Great quantities of the cloth were blown out of the guns, and large pieces were extracted by the sponge. The seam is rarely consumed, and frequently not even charred.

SHOT.

Most of the shot which we used at the testing battery were old, and proved to be of very inferior quality. They were extremely brittle, and many had large cavities. The use of such shot may have caused the bad firing which has sometimes been made on board ships, and for which it was difficult to account.

WADS.

The grommet wad was found to answer very well, when it fitted the shot and the bore of the gun; but if it was too small for the shot, it would not jam it; and if it was too large, it would not readily go square into the gun. For more rapid and easy work, we cut them into two parts, and found that they held the shot in place quite as well as the best full-sized wad.

On one occasion, when our wads were scarce, and we did not wish to wait for more to come from Norfolk, the grommet wad was cut into four parts, which were found to work perfectly well. We tried the experiment by running out the 9-inch gun down an inclined plane of 5° depression, with all the power of twelve men, and the muzzle depressed 15°, and four inches of the grommet wad held a 9-inch shot of 92 pounds perfectly secure. Hence, we would recommend that hereafter the wads be made, as at present, on the wad-making machine, and then cut into three or four pieces, and tied up in bundles of ten or twelve each. We suggest making them on the machine still, because they will jam better for having the curve of the bore.

Commander Farragut was assisted in conducting these tests by Lieutenants H. H. Bell, Percival Drayton, and Wm. Rogers Taylor.

Abstract of experiments made at Old Point Comfort in 1852, 1853, *showing and weight.* (sh. *is used for shells,*

GUNS.						AMMUNITION.				NUMBER OF FIRES WHICH					
										With 1 shot or shell.		With 2 shot or shells.		With 3 shot.	
Register No. of the guns.	Calibre.	Weight.	Year of pattern.	Where made.	When inspected.	Weight of single shot.	Weight of single shell.	Windage.	Strength of powder; initial velocity or range.	Number of fires.	Charge of powder.	Number of fires.	Charge of powder.	Number of fires.	Charge of powder.
		cwt. qr. lbs.				*lbs.*	*lbs.*		*Yards.*		*lbs.*		*lbs.*		*lbs.*
11	10 in.	88 0 3	1841	W. P. F...	1842	130	103	0.18	307	sh. 475	10	sh. 28	8	....	...
										s. 5	14	s. 5	14	s. 5	14
2	9 in.	80 2 14	experimental.	W. P. F...	1850	92	76.20	.16	293	sh. 269	10	12	6	....	...
										sh. 49	9¼				
										sh. 82	9				
										sh. 40	8¼	Fired		at Wash	
										sh. 10	7¼				
										sh. 2	7				
										sh. 6	6				
										sh. 19	4½				
										s. 502	10	s. 9	10		
372	8 in.	62 2 09	1851	W. P. F. .	1851	63	52	.16	288 to 315	sh. 475	9	sh. 25	6	....	...
										s. 5	12	s. 5	12	s. 5	12
34	8 in.	55 3 16	1845	F. P. F....	1846	64	50	.16	288 to 295	sh. 40	9	sh. 26	6	....	...
										sh. 72	8	sh. 10	5		
										sh. 366	7	sh. 8	4½		
										sh. 10	4½	sh. 7	4		
										s. 5	10	s. 5	10	s. 5	10
160	8 in.	56 1 01	1845	A & Co ...	1852	65	oz. 49.8	.16	288 to 293	sh. 475	7	sh. 21	6	....	...
												sh. 4	5		
										s. 5	10	s. 5	10	s. 5	10
167	8 in.	55 3 10	1845	A & Co ...	1852	64	49.5	.16	288 to 293	sh. 476	7	sh. 22	6	....	...
												sh. 2	5		
										s. 5	10	s. 5	10	s. 5	10
11	64 pdr.	106 0 18	1848	W. P. F...	1849	64	.....	.16	307	s. 400	16	s. 100	8	s. 2	20
574	32 pdr.	56 2 08	1846	W. P. F...	1852	32.12	.....	.25	1,596	s. 400	9	s. 100	6	s. 5	s12
597	32 pdr.	57 1 27	1846	W. P. F...	1850	32.12	.....	.25	1,574	s. 400	9	s. 100	6	s. 5	12
657	32 pdr.	58 2 10	1846	T. F.....	1852	32.12	.....	.25	258, 288, E	s. 400	9	s. 100	6	5	s12
671	32 pdr	57 1 05	1846	F. P. F....	1852	32.12	.....	.25	1574, 1596	s. 400	9	s. 100	6	s. 5	12
688	32 pdr.	57 2 25	1846	F. P. F....	1852	32.12	.....	.25	1574, 1596	s. 400	9	s. 100	6	s. 5	12
695	32 pdr.	57 0 24	1846	T. F.....	1851	32.12	.....	.25	1,574	s. 400	9	s. 100	6	s. 5	12
707	32 pdr.	58 2 03	1846	B. F.....	1852	32.12	.....	.25	1,574	s. 400	9	s. 100	6	s. 5	12
710	32 pdr.	58 1 16	1846	B. F.....	1852	32.12	.....	.25	1,574	s. 400	9	s. 100	6	s. 5	12
21	32 pdr.	51 2 18	1846	J. R. A....	1847	32.12	.....	.25	1,596	s. 400	8	s. 100	5	s. 5	12
51	32 pdr.	51 1 16	1846	J. R. A....	1847	32.12	.....	.25	1,596	s. 400	8	s. 100	5	s. 5	11
20	32 pdr.	47 2 01	1846	C. A. & Co.	1846	32.12	.....	.25	1,574	s. 400	7	s. 100	5	s. 5	10

the endurance of different shot and shell guns, arranged according to calibre and s. *for shot, in the table.)*

THE GUNS STOOD BEFORE BURSTING.																REMARKS.							
With 4 shot.		With 5 shot.		With 6 shot.		With 7 shot.		With 8 shot.		With 9 shot.		With 10 shot.											
Number of fires.	Charge of powder.	Number of fires.	Charge of powder.	Number of fires.	Charge of powder.	Number of fires.	Charge of powder.	Number of fires.	Charge of powder.	Number of fires.	Charge of powder.	Number of fires.	Charge of powder.	Tensile strength.	Density.								
	lbs.		*lbs.*		*lbs.*		*lbs.*		*lbs.*		*lbs.*		*lbs.*										
....	....	....	....	....	....	....	....	....	....	....	....	....	....	30.594	7247.5	Did not burst.							
s. 5	14	5	14	5	14	5	14	5	14														
								52	18														
								11	20														
....	....	....	....	....	....	....	....	....	....	....	....	....	....	35.560	7.261								
ingt	on.																						
....	....	....	....	....	....	....	....	....	....	....	....	....	....	33.904	7.285								
s. 5	12	s. 5	12	s. 5	12	s. 5	12	s. 5	12	s. 5	12	s. 5	12										
												s. 53	16										
....	....	....	....	....	....	....	....	....	....	....	....	....	....	27.100	7.200								
....	....	....	....	....	....	....	....	....	....	....	....	....	....	30.547	7.359								
s. 5	10	s. 1	10	Mu	zzl	e ha	d b	een	pre	viou	-ly	split	by	a shell.									
....	....	....	....	....	....	....	....	....	....	....	....	....	....	*38.332	*7.280	Did not burst. See report.							
s. 5	10	s. 5	10	s. 5	10	s. 5	10	s. 5	10	s. 5	10	s. 5	10										
												s. 88	14										
												s. 17	16										
....	....	....	....	....	....	....	....	....	....	....	....	....	....	*30.889	*7.230								
s. 4	12	....	....	....	....	....	....	....	....	....	....	....	....	*28.910	*7.169	With 11 shot.		With 12 shot.		With 13 shot.		With 14 shot.	
s. 4	12	....	....	....	....	....	....	....	....	....	....	....	....	*32.422	*7.280								
														34.366	7.266								
s. 5	12	s. 5	12	s. 5	12	s. 1	12	....	....	....	....	....	....	*27.047	*7.194								
														33.953	7.255								
s. 5	12	s. 5	12	s. 5	12	s. 2	12	....	....	....	....	....	....	*26.573	*7.238				*lbs.*		*lbs.*		*lbs.*
s. 5	12	s. 5	12	s. 5	12	s. 5	12	s. 5	12	s. 5	12	s. 5	12	*34.431	*7.316	3	12						
s. 5	12	....	....	....	....	....	....	....	....	....	..	....	....	*23.290	*7.197								
														26.408	7.197								
....	....	....	....	....	....	....	....	....	....	....	....	....	....	*25.548	*7.185								
														24.699	7.151								
s. 5	12	s. 5	12	s. 1	12	....	....	....	....	....	....	....	....	*23.939	*7.134								
														25.642	7.197								
s. 5	12	s. 5	12	s. 5	12	s. 5	12	s. 5	12	s. 5	12	s. 5	12	29.355	7.254	s. 5	12						
s. 5	11	s. 5	11	s. 5	11	s. 3	11	....	....	....	....	....	....	28.913	7.253								
s. 5	10	s. 5	10	s. 5	10	s. 5	10	s. 5	10	s. 5	10	s. 5	10	30.976	7.195	s. 5	10	5	10	5	10	30	12

NOTES.

No. of gun.	Calibre.	Remarks.
167	8-inch of 55 cwt..	Did not burst. See report.
11	64-pounder.....	See report.
574	32-pdr. of 57 cwt..	The vent of this gun wore very rapidly. Shot supposed to have wedged four feet eight inches from muzzle.
597	.....do.....	Vent wore away very rapidly.
657	.....do.....	
671	.....do.....	Shot supposed to have wedged 27 inches from bottom of bore.
688	.....do.....	Shot appeared to have wedged.
695	. .. ..do.....	Metal softer than usual.
707	.....do.....	
710	.....do.....	
21	32-pdr. of 51 cwt..	
51	.....do.....	Shot appeared to have wedged.
20	32-pdr. of 47 cwt..	Shot had evidently broken and scored the bore several fires before the gun burst.
11	10-inch	Did not burst. See report.
2	9-inch	This gun was made for experimental use, and was tested differently from the other guns. See report.
372	8-inch of 63 cwt..	See report.
34	8-inch of 55 cwt..	This gun, in its original form, had been fired 200 times at Washington, after which 200 pounds of metal was turned off from the chase, and again fired at Washington 214 times. At the testing-battery it was fired 100 times with 7 pounds powder and one shot, and 13 times with 6 pounds powder and two shells. At this fire a shell exploded in the gun and cracked it from the muzzle two feet towards the trunnions. The same firing was continued twelve times more, which increased the crack three quarters of an inch. A hole was then drilled at the end of the crack. The first bursting charge, with 10 pounds of powder and one shot, broke out about two feet of the upper part of the chase, from the end of the old crack to the face of the muzzle, and extended the crack fourteen inches. The second fire the crack extended one and a half inches; at the third, four inches; at the fourth, twelve inches; at the fifth, three inches; at the sixth, three-quarters of an inch; at the seventh fire, (of bursting charges,) another piece, about three feet long, was thrown off the upper part of the chase, and the crack extended three inches to rear of trunnion, tending downwards; at the fourteenth fire the crack extended seven inches further; at the fifteenth fire the gun burst by throwing off the top part of it.
160	8-inch of 56 cwt..	Before proceeding to subject this gun to the extreme tests, a shell was exploded in it about eighteen inches from the muzzle. (See report.) No. 160 and No. 34, which were first cracked near the muzzle, were the only guns which did not separate through the vents when they were burst.

In some cases the strength of the powder used is shown by the range from the eprouvette, in others by the initial velocity, and in some by both.

The 32-pounder shot were generally of full weight. The 8-inch and 64-pounder shot weighed about 64 pounds, and the shells 50 pounds; the 9-inch shot weighed 92 pounds, and the shells about 71.2 pounds; the 10-inch shot weighed 130 pounds, and the shells 103 pounds.

The density, or specific gravity, and the tensile strength of the respective guns, are given in their proper columns. Those marked with an asterisk (*) give them as reported on original inspection; those without such mark show results ascertained from fragments after the gun had been destroyed, or the tests had been discontinued. Some of these fragments were large. Two halves of different guns, (9-inch No. 2, and 8-inch No. 34,) which extended from the cascabel to from fifteen to twenty inches forward of the trunnions, were used to ascertain the relative tenacity and density of specimens taken from the exterior "surface" down towards the axis, and from the face of the fracture at different places, one set near to the "exterior," and one set near to the bore, or to centre of the breech. Calling the first of these sets "exterior" and the other "interior," the experiments gave the following results:

From the 9-inch gun No. 2.

	Density.	Tensile strength.
The mean of 13 "exterior" specimens gave	7.2625	29.951
The mean of 14 "interior" .....do.....	7.2625	32.074
The mean of 5 "surface" .....do.....	7.2600	32.326
By sinking heads at inspection, mean of two sets of trials.....	7.2565	34.543

From the 8-inch of 56 cwt., No. 34.

The mean of 10 "exterior" specimens gave	7.1750	23.369
The mean of 11 "interior" .....do.....	7.2045	25.718
The mean of 5 "surface" .....do.....	7.1808	24.871
Specimen from face of muzzle before testing	7.2000	27.140

Table showing the diameters of vents at the vent-field, taken at intervals from guns tested at the naval testing battery, Old Point Comfort, Virginia, in 1852 *and* 1853.

No. of gun.	Calibre.	Weight.	100 fires.	200 fires.	300 fires.	400 fires.	500 fires.	Remarks.
		Cwt. qrs. lbs						
11	10-inch.	86 0 03	.25	.26	.26½	.27	.28	
2 Ex.	9-inch.	80 2 14	.25	.26	.31	.34	.40	
372	8-inch.	62 3 09	.23	.24	.25	.27	.30	
34	...do...	55 3 16	.....	.....	.....	.24	.26	
160	...do...	56 1 01	.20½	.21	.23	.23	.23½	
167	...do...	55 3 10	.20½	.21	.22	.22	.23	
11	64-pdr.	106 0 18	.24	.27	.29	.35	.41	
574	32-pdr.	56 2 08	.25	.30	.37	.43	.75 by .50	
597	...do...	57 1 27	.25	.30	.35	.40	.25	No. 597 was bushed after 400 fires.
657	...do...	58 2 10	.23	.26	.31	.38	.40	
671	...do...	57 1 05	.25	.26	.31	.37	.50	
688	...do...	57 2 25	.25	.30	.35	.44	.62	
695	...do...	57 0 24	.25	.27	.32	.38	.45	
707	...do...	58 2 03	.25	.27	.30	.35	.38	
710	...do...	58 1 16	.25	.27	.30	.35	.40	
21	...do...	51 2 18	.21	.21	.25	.30	.37	
51	...do...	51 1 16	.21	.25	.27	.37	.50	
20	...do...	47 2 01	.22	.25	.31	.35	.37	

Table showing the results of double-shell firing with loaded shells.

Calibre.	Weight.	Number of fires.	Charge of powder.	Single or double shells.	With or without a wad.	Number broke in the gun.	Number exploded.	Number fell whole
9-inch.....	80 cwt..	6	10 lbs.	2 shells ..	With	3	2	7
Do	...do...	1	6 "	....do....	....do....	0	1	1
Do	...do...	2	10 "	....do....	Without..	1	1	2
Do	...do...	1	6 "	....do....	....do....	2	0	0
8-inch.....	.....	11	6 "	....do....	With	7	5	12
Do	.....	7	5 "	....do....	....do....	6	2	6
Do	.....	5	4 "	....do....	....do....	1	6	3
Do	.....	2	4 "	....do....	Without..	2	1	1
32-pounder .	57 cwt..	5	6 "	....do....	With	0	2	8
Do	...do...	4	6 "	....do....	Without..	3	2	3

Table showing the results of double-shell firing with unloaded shells.

Calibre.	Number of fires.	Charge of powder.	Single or double shells.	With or without wad.	Number broke.	Number unbroken.
9-inch.....	2	6 pounds.....	2 shells....	Without..	0	4
8-inch.....	12	.....do.....	....do.....	With	0	24
Do	13	.....do.....	....do.....	Without..	1	25

	Aggregate.	Broken.	Exploded.	Unbroken.
Loaded shells	88	25	20	43
Unloaded shells	54	1	0	53
Loaded, with wad between.....	70	17	16	37
Loaded, without wad	18	8	4	6
Unloaded, with wad	24	0	0	22
Unloaded, without wad	30	1	0	29

Ten-inch shell-gun of 88 *cwt., No.* 11.—Two specimens drilled from muzzle face:

	Specific gravity.	Tensile strength per square inch.
No. 1	7.248	29643
No. 2	7.247	31545

Fracture rather uneven; predominating color whitish, intermixed with carbonaceous spots; brilliant specks scattered over the surface.

Eight-inch of 55 *cwt., No.* 167, (*Alger.*)—Two specimens drilled from muzzle face.

	Specific gravity.	Tensile strength per square inch.
No. 1	7.297	38794
No. 2	7.283	36606

Fracture rather uneven; grain not remarkably close and fine; color generally whitish, interspersed with small carbonaceous spots; brilliant specks scattered over the surface.

The following tests were made in 1842, 1845, *and* 1846, *and are serted here to show the strength and endurance of* 32-*pounder guns classes differing from those tested by Commander Farragut.*

In 1842, two of the 42 cwt. class, which had been cast from different qualities of iron, were proved to extremity. (Made by Cyrus Alger and Co.)

One was fired—

3 times with 9 pounds powder and 1 shot and wad.
3....do...10.....do.....1 shot.
3....do...11.....do.....1 shot.
3....do...12.....do.....1 shot.
3....do...12.....do.....2 shot and wads.
2....do...12.....do.....3.....do.

Total 17

The other was fired—

3 times with 9 pounds powder and 1 shot.
3....do...10.....do.....1 shot and wad.
3....do...11.....do.....1 shot.
3....do...12.....do.....1 shot.
3....do...12.....do.....2 shot and wads.
3....do...12.....do.....3 .....do.
2....do...12.....do.....4 .....do.

Total 20

The guns burst at the last discharges.

The heaviest service-charge for this class of guns is 6 pound powder and 1 shot.

In 1845, two of the 27 cwt. class of 32-pounder guns, made by Cyrus Alger & Co., were not received in consequence of being defective on their surfaces. They were turned down to the weight of 25 cwt., and each of them was fired as follows, (a wad between each and over the last shot:)

Time with 7 pounds powder and 1 shot.
...do... 8.....do.....1 shot.
....do... 9.....do.....1 shot.
....do...10.....do.....1 shot.
1....do... 7.....do.....1 shot.
1....do... 8.....do.....1 shot.
1....do... 9.....do.....1 shot.
1....do...10.....do.....1 shot.
3....do...10.....do.....3 shot.
3....do...11.....do.....2 shot.
3....do...11.....do.....3 shot.
3 times—1 of 12, 1 of 13, and 1 of 15 pounds powder and 2 shot.
3 times—1 of 10, 1 of 12, and 1 of 13 pounds powder and 2 shot.
3 times with 12 pounds powder and 2 shot.
3....do....9.....do.....3 shot.
3....do....9.....do.....4 shot.

1 time with 9 pounds powder and 5 shot.
1....do... 9.....do.....6 shot.
1....do...10.....do.....6 shot.

And sixteen times more with same number of shot, and the charge of powder increased one pound at each fire.

One of the guns burst at the 50th fire, with 25 pounds powder and 6 shot, and the other at the 51st fire, with the same charge.

The heaviest service charge for this class of guns is 4 pounds powder and 1 shot.

Report, dated June, 1846, *of extraordinary proof of No.* 3 *trial* 32-*pounder of* 32 *cwt., new class, at the Tredegar foundry, near Richmond, Virginia.*

58 fires with 4½ pounds powder, 1 shot and 1 wad.
1...do... 6.....do..... 1... do...1 wad.
1...do... 7.....do..... 1... do...1 wad.
1...do... 8.....do..... 1... do...1 wad.
1...do... 9.....do..... 1... do...1 wad.
1...do...10.....do..... 1... do...1 wad.
1...do...10.....do..... 2... do...1 wad.
1...do...12.....do..... 2... do...1 wad.
1...do...13.....do..... 2... do...1 wad.
1...do...15.....do..... 2... do...1 wad.
1...do...16.....do..... 2... do...1 wad.
1...do...17.....do..... 2... do...1 wad.
1...do...18.....do..... 2... do...2 wads.
1...do...19.....do..... 2... do...3 wads.
1...do...20.....do..... 2... do...3 wads.

The gun broke with the last charge, being the 14th proof-charge, and the 72d time fired. A shot at the last fire broke, and at eighteen inches from the muzzle was driven into the metal of the bore, seemingly wedged by the shot behind.